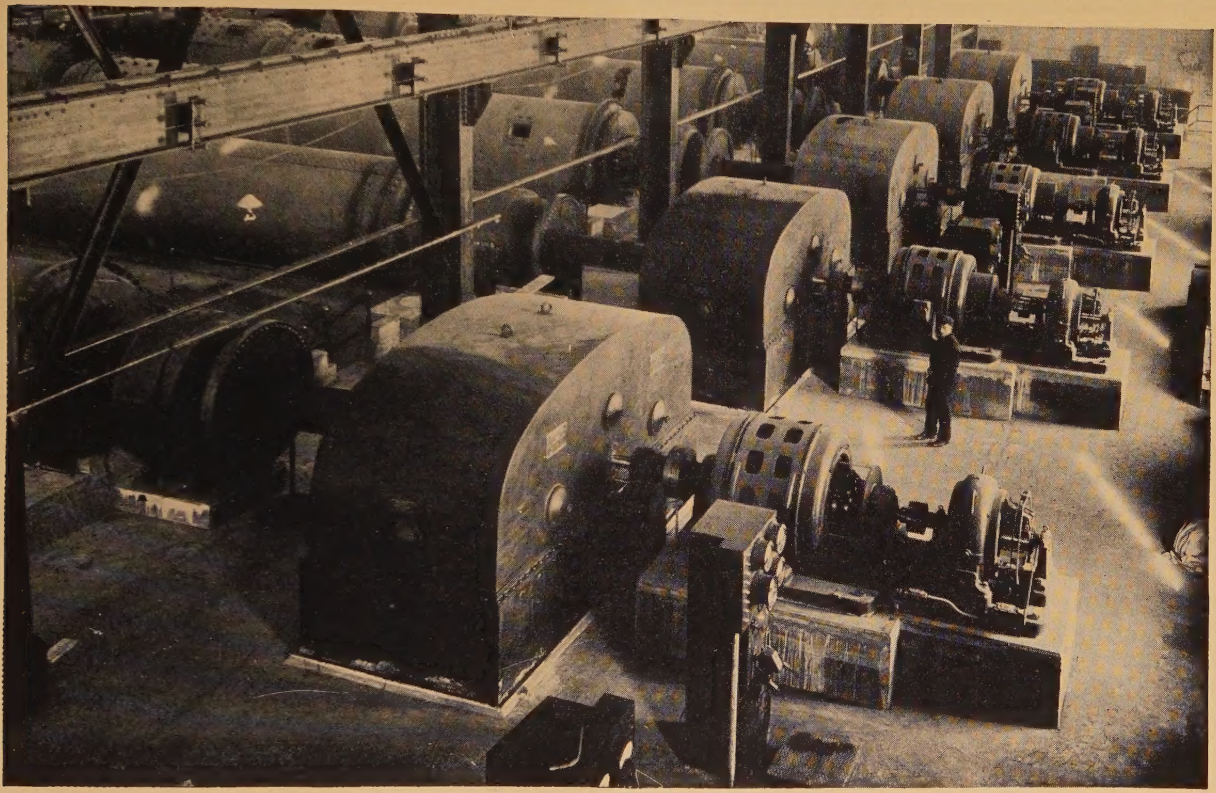
UNI-KOM

GRINDING MACHINES WITH SYMETRO DRIVES



THE UNI-KOM* is the latest development in grinding mills. It combines in one machine the Unidan mill with the Kominuter, the Kominuter section being ***overhung*** on the feed end of the Unidan section. A special type of slide shoe bearing is used for the trunnion between the two mill sections.

The screen is internal and is located between the Kominuter and Unidan sections, the tailings being returned to the Kominuter for regrinding. Changing the size of screen and adapting the size of grinding bodies in each compartment to the grinding work required to give the necessary flexibility in the grinding operation.

This gives a mill having four grinding compartments and one screening compartment.

The motor is direct connected through the SYMETRO gear reduction unit to the outlet end of the Unidan mill section.

The advantages of this new mill are obvious. It combines in one machine all the benefits of the two-stage (ballmill and tubemill) grinding units with the advantages of the compartment mill. Larger pieces may be fed to it than to the straight shell, standard compartment mill, particularly on cement raw materials. Low installation cost and high efficiency are other advantages.

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The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of portland cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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Closed-Circuit Dry Grinding Attains Fineness and Large Output

Compeb Mill Hooked Up with Air Separators at Raw End of Missouri's Independence Plant—Analysis Shows 93 Per Cent Minus 200-Mesh

AMONG the various units of new and improved grinding equipment installed in cement plants during 1931 is the installation of a large 3-compartment compeb mill, operating in closed circuit with two 16-ft. air separators at the Independence (Mo.) plant of the Missouri Portland Cement Co. The equipment was designed for dry-grinding of the raw material at this plant.

The compeb mill installed, which is of Allis-Chalmers manufacture, is, in fact, a combination ball and tube mill, the outward appearance being quite similar to a tube mill. The interior construction, however, is quite different, as, for example, in the use of the two division heads that divide the mill into three compartments.

The compeb mill is designed to reduce the crushed raw material from sizes ranging up to 1½ in. down to the fineness of the finished "flour," thus eliminating the use of auxiliary grinding equipment and other features involved in two-stage grinding installations. The motor driving the mill is a 900-h.p., 180 r.p.m., 2,200-volt, General Electric "super-synchronous" motor.

Division Heads Between Compartments

A study of the longitudinal cross-section (Figure 2) and the flow sheet (Figure 5) will aid in following the operation of the compeb mill in this dry-grinding installation. Observe, in particular, the peripheral screen around the division head between the first and second compartments. As the raw material passes through the first, or preliminary, compartment, it passes into the first division head by being screened through the perforated screen plates that comprise the wall of the division head on that side. The material then drops through holes placed annularly around the shell, and falls upon the peripheral screen, which is suspended by brackets from the outer shell of the mill. The material that is too coarse to pass through this peripheral screen is moved toward the feed end (toward the left in Figures 2 and 5) by veins and discharges into a trough. This over-size material in the trough is reclaimed by scoops and returned, through special nozzles, to the preliminary compartment, where it is reground.

Classified by Air Separators

The finer material that does pass through the peripheral screen is dropped upon a flat surface. The spirals on the outside of the frame of the peripheral screen move the material toward the second compartment, to be droppd in a sump, and from there it is fed to the first air separator for classification. This separator classifies this discharge from the preliminary compartment, sending the fines to a collecting screw feeding the Fuller-Kinyon pump and returning the coarser "reject" to the second compartment for further reduction.

In somewhat similar manner, the discharge from the second compartment is fed to the second air separator, for further classification. The fines are again sent to the collecting screw, while the coarser material is returned to the third compartment for further grinding. This third

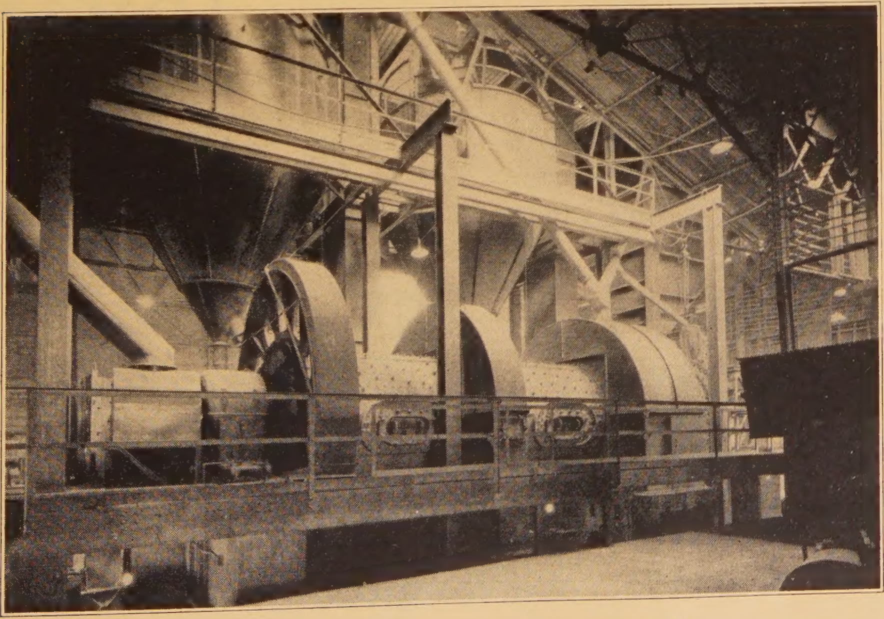

Figure 1. New compeb mill installed in closed-circuit with air separators, at Independence plant of Missouri Portland Cement Co.

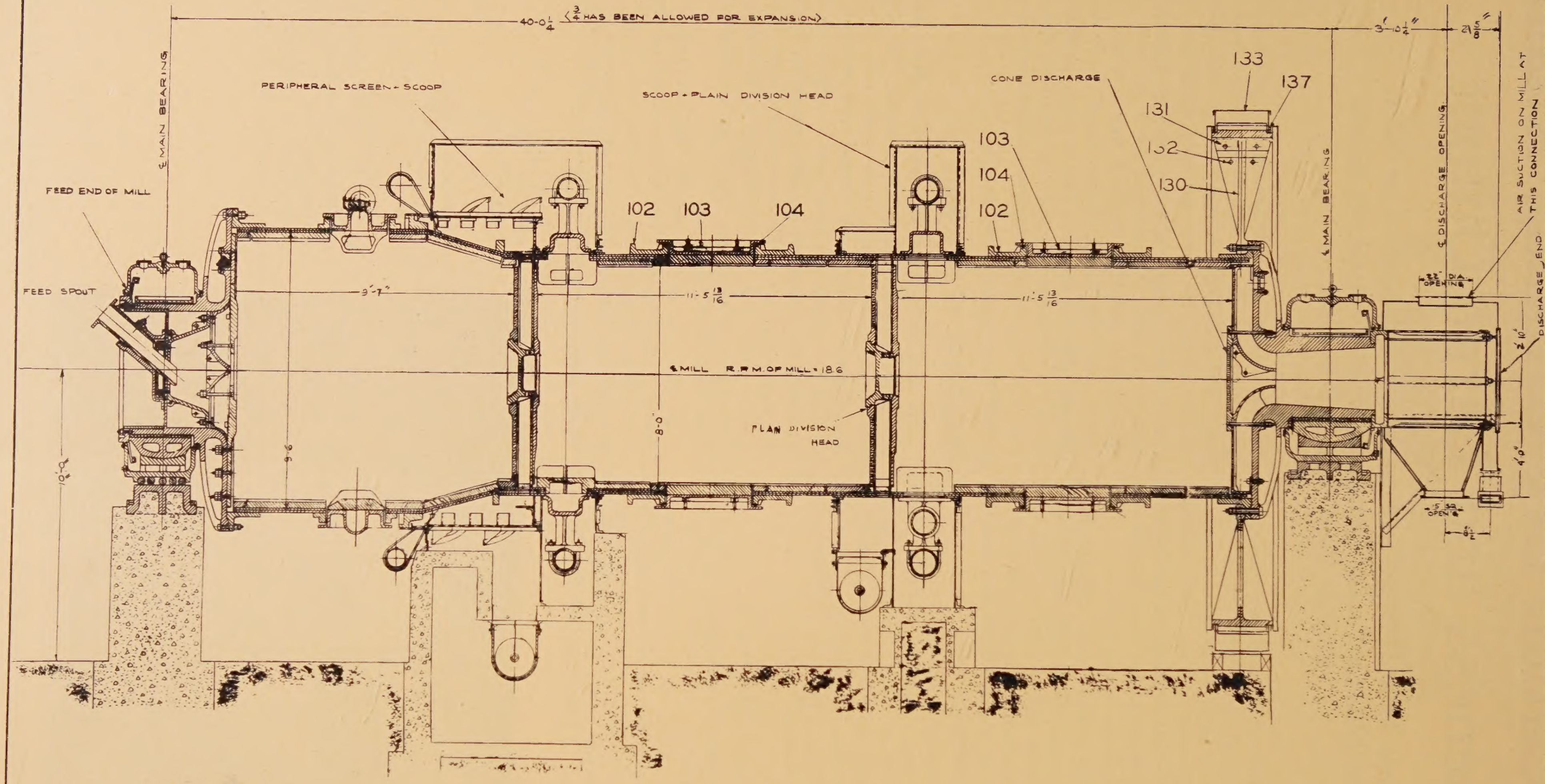

Figure 2. Longitudinal cross-section through 35-ft. compeb mill

102. Manhole frame.
103. Manhole door.
104. Manhole door packing.
130. Spur gear ring, in halves.
131. Spur gear ring filler piece.
132. Bolts for spur gear ring.
133. Gear guard.
137. Gear guard felt sealing ring.

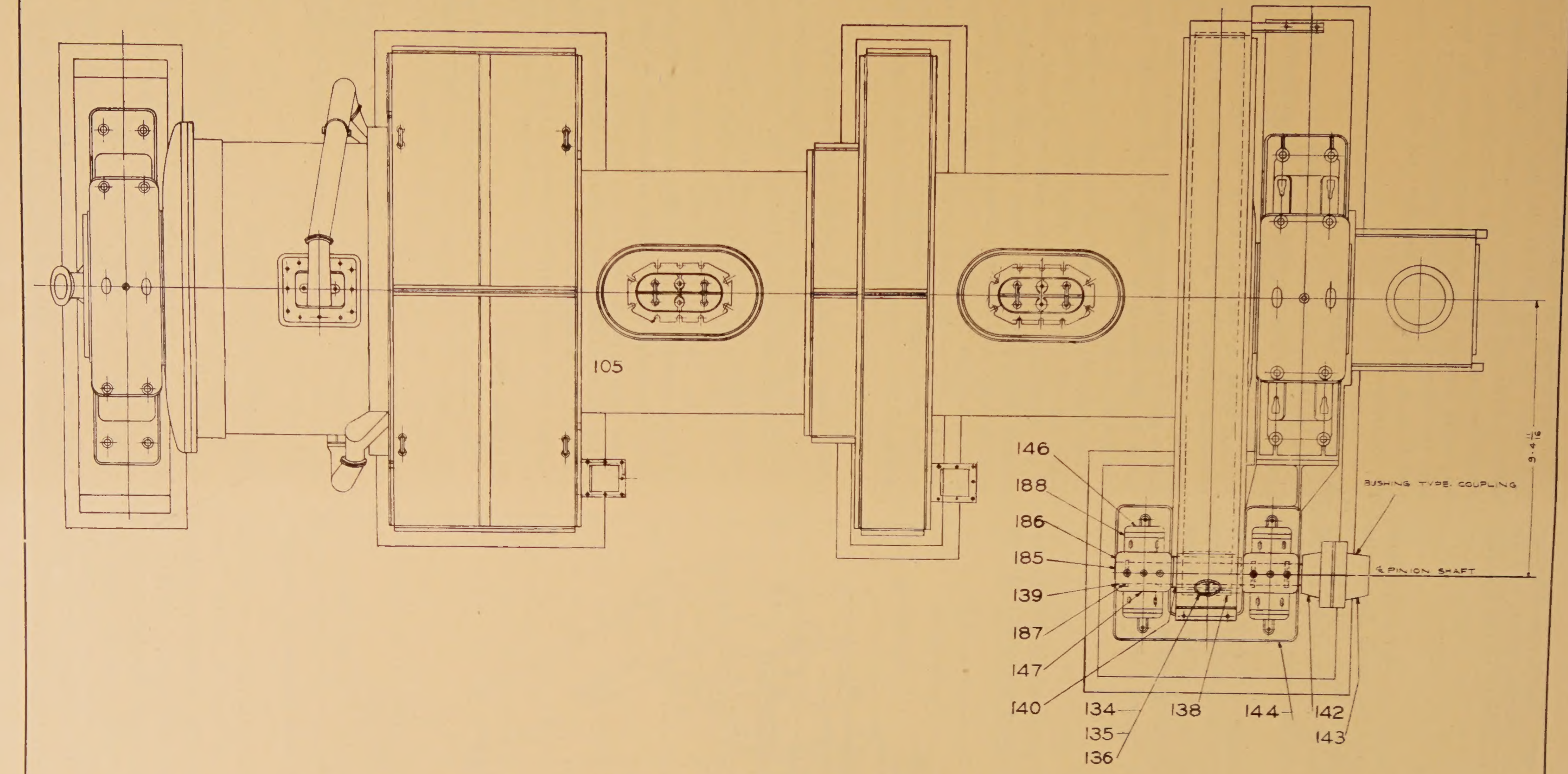

Figure 3. Top view of 35-ft. compeb mill

105. Manhole door bolts.
134. Gear guard door.
135. Gear guard door frame.
136. Gear guard door latch.
138. Spur pinion.
139. Pinion shaft spur pinion end.
140. Pinion shaft spacing collar.
142. Bushing type coupling, female half.
143. Bushing type coupling, male half.
144. Pinion shaft bearing double sole plate.
146. Pinion shaft bearing base.
147. Pinion shaft bearing cap.
185. Pinion shaft bearing felt packing.
186. Pinion shaft bearing felt packing ring.
187. Pinion shaft bearing oil ring.
188. Pinion shaft bearing wedge blocks.

compartment is operated in open circuit, the discharge joining the fines in the common collecting screw, and the finished product being pumped directly to the blending bins.

Dimensions of Compeb Mill

The compeb mill installed at the raw end of the Independence plant is 35 ft. long, and the length between the center lines of its main bearings is 40 ft. In Figure 1 the discharge end of the mill is at the left of the picture, while in Figures 2, 3 and 5 the discharge end is at the right.

The mill has an inside diameter of 9 ft. 6 in. in the preliminary compartment and 8 ft. in the two finishing compartments. The clear inside length of the preliminary compartment is 9 ft. 7 in., while the length of each of the two finishing compartments is a small fraction less than 11 ft. 6 in.

The Air Separators

The two air separators which operate in closed circuit with the compeb mill are Raymond mechanical air separators, each 16 ft. in diameter, similar in design to the 14-ft. separator illustrated on page 57 of the October (1931) issue of the *Cement Mill Edition* of CONCRETE. As there stated, this separator makes use of the principle of centrifugal action, but in conjunction with mechanical attachments consisting of rapidly revolving paddles, or whizzer arms, which knock the coarse particles out of the air current created within the separator. The separator contains an inner cone and an outer cone, or shell.

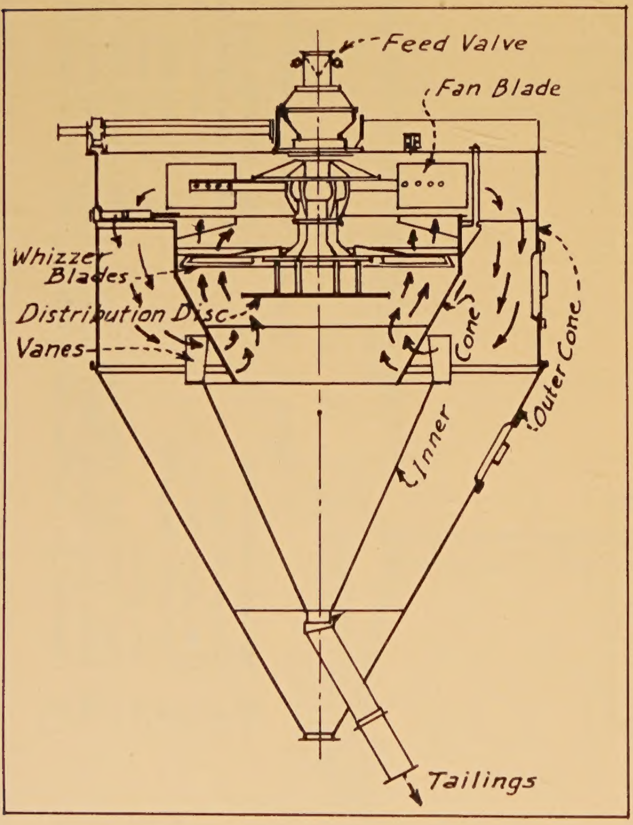

Figure 4. Diagrammatic section through air separator

The pulverized raw material coming from the compeb mill enters the separator at the top, through a hollow vertical shaft, and drops on a horizontal distribution disc within the inner cone. The disc is revolving rapidly and this rapid rotation has a tendency to throw the material over the edge of the disc and across an upward air current between the edge of the disc and the inner cone of the separator.

Action of Air Current

The strong upward air current picks up all the particles that drop from the edge of the disc and carries them up into contact with the whizzer arms. These rapidly revolving arms, or paddles, knock the over-size particles out of the current. The action of the whizzer arms reduces the amount of fine dust which, without them, would be discharged to the tailings, and they produce the further result of preventing a "leakage" of over-size material into the finish bins.

The upward air current is caused by a fan in the upper part of the separator, which drives a strong current of air downward between the inner and outer cones, the current entering the inner cone through deflector vanes near its base, then rushing upward within the inner cone to complete the circulation. It is here that the upward current picks up the particles of pulverized raw material as they drop from the edge of the distribution disc. A sketch of the air separator, showing its principal features, is shown in Figure 4.

Flow Sheet Shows Closed-Circuit Hook-Up

The flow sheet (Figure 5) shows, in diagrammatic form, the closed-circuit hook-up between the first and second compartments of the compeb mill, and the air separators. This circuit, as previously stated, consists of a classification of the material discharged from the first, or preliminary, compartment, resulting in the production of finished material and a coarse reject which is sent to the second compartment for further grinding. The second air separator classifies the discharge from the second compartment, producing finished material and sending the coarser reject to the third compartment for final grinding.

Grinding Media

The grinding media in the preliminary compartment of this compeb mill consist of forged steel balls ranging in size from 4 in. down to 2½ in. in diameter, the total charge weighing 58,000 lb.

The second compartment of the mill is charged with 54,000 lb. of "concavex" grinding media 1¼ in. diameter, and the third compartment carries a charge of 54,000 lb. of "concavex" ⅞ in. in diameter.

The Performance Record

The installation at the Independence plant is performing in excellent fashion, the output being considerably in excess of the expected capacity. The feed to this mill is 1-in. material, and consists of limestone and shale.

The mill is grinding dry raw material at the rate of 55 tons per hour to a fineness of 93 per cent minus 200-mesh, as the analysis given in the table indicates.

The mill is equipped with gates so that either of the

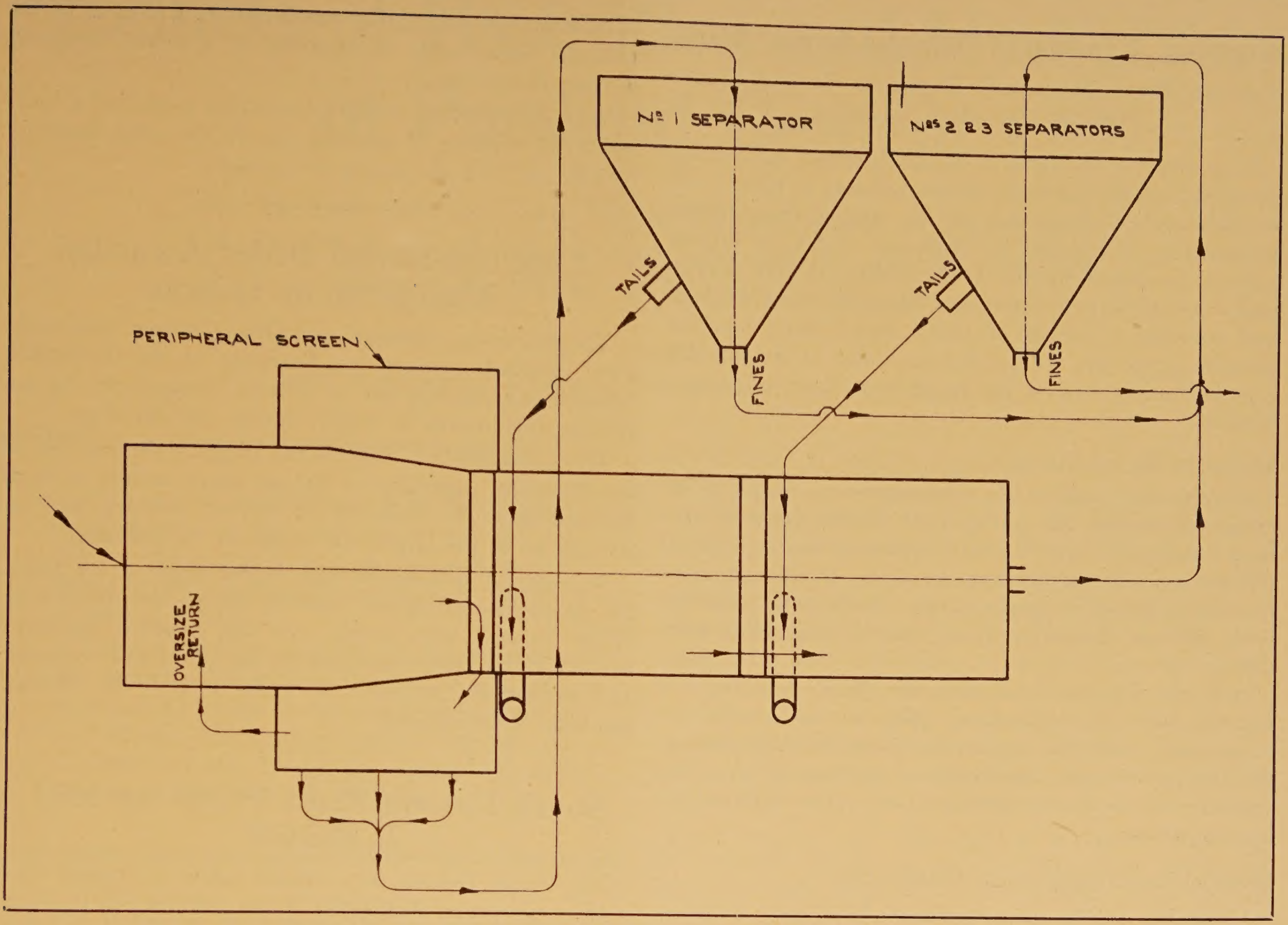

Figure 5. Flow sheet showing closed-circuit hook-up between compeb mill and air separators

FINENESS ANALYSIS OF RAW MATERIAL—PASSING 200-MESH

Discharge 1st Compartment	41.0	1st Separator Feed
Feed 2nd Compartment	13.5	Rejects
	97.5	Fines
Discharge 2nd Compartment	65.0	2nd Separator Feed
Feed 3rd Compartment	25.5	Rejects
	96.5	Fines
Discharge 3rd Compartment	87.5	3rd Compartment
	97.5	Collector (Dust)
Composite Fines, 3rd Compartment	93.0	Average Mill Stream

two separators can be by-passed and the mill thus operated in open-circuit or as a straight compeb.

Shipped as Complete Units

This compeb mill was shipped as a complete unit from the plant of the equipment manufacturer to the cement plant, on a flat car fitted especially for the purpose. This complete assembly included the two division heads and all other internal parts, all in place. At the cement plant the mill was lifted directly from the flat car into its bearings.

Dust Collectors Also Installed

A 5-compartment dust collector, similar to the installation at the same company's plant at Prospect Hill, Mo., was installed at the Independence plant in conjunction with the compeb mill and the air separators.

Acknowledgments

The Allis-Chalmers Manufacturing Co., of Milwaukee, supplied and installed the compeb mill here described, as well as the dust collector equipment. The air separators were manufactured and installed by Raymond Brothers Impact Pulverizer Co., of Chicago. The latter company also supplied two additional air separators at the finish end, which were hooked up in closed-circuit with tube mills.

Reopening of North American Plant on February 1

A 60-day shutdown period terminated when the North American Cement Co. plant at Howes Cave, N. Y., reopened on February 1. The force recalled totals 110 men, and it is hoped to maintain operations without a layoff in 1932.

Lehigh Shows $79,000 Profit for 1931

The Lehigh Portland Cement Co. for 1931 reports a net profit of $79,328 after depreciation, taxes, etc.

Per-share earning last year amounted to 38 cents on 204,969 shares of 7 per cent preferred stock, against $1.46 a share on 450,348 common shares, after preferred dividends, in the year ended November 30, 1930.

Combat Claims of Injury From Dust

Cement Plant Managers Urged to Be on Guard Against Racketeer Lawyers

Considered in the light of results obtained in scientific investigations the portland cement industry is rather well fortified against claims that the dust arising from cement manufacture is harmful to employes. Extensive investigations conducted by the U. S. Public Health Service under actual service conditions at a dry-process plant, and covering a period of three years,[1] have supplied scientific proof that neither the stone dust at the raw end nor the cement dust at the finish end cause pulmonary diseases.

Urged to Be on Guard

Nevertheless, cement plant managers are urged to be on guard against the activities of shyster lawyers who have developed a new "racket," mainly at the expense of the silica producing industry, by means of damage suits brought in behalf of employes who claim to be suffering from silicosis. Usually a doctor acts in conjunction with the lawyer.

It is not difficult to visualize the effect on a jury of laymen, when the impassioned pleas of the lawyer are co-ordinated with the supposedly authentic diagnoses of the doctor. Scientific investigations proving the harmless character of the dust of cement plants carry little weight by comparison.

Medical Examinations As Safeguards

Up to the present time no reports have come to hand of personal damage actions of this nature having been brought against cement manufacturing companies. The fact remains that it would be only a short step from the silica products industry to the cement industry, if the racketeers should find opportunities diminishing in the former group.

Careful medical examination of new employes and periodic check-ups of all employes will go far toward safeguarding cement companies against these activities, so far as personal damage suits are concerned.

Many Suits Claiming Property Damage

That a real danger exists may be seen from the number of property damage suits brought against cement companies in recent months. One plant in Texas has been made defendant in three or four property damage claims, in which each of the claimants alleges damage from dust, and all are represented by the same lawyer. In another case the proprietor of a greenhouse has brought suit on the ground that dust from a cement plant 2½ miles away settles on the glass and prevents the unobstructed entrance of sunlight, thereby stunting the growth of the plants. Doubtless in all these cases a lawyer has succeeded in convincing these litigants that easy money is in sight.

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[1] See Cement Mill Edition of CONCRETE, April, 1930, pages 115-117, and May, 1930, pages 114-117.

Barging of Cement Planned on Lakes-to-Gulf Waterway

With completion of the lakes-to-gulf waterway in 1932, the Marquette Cement Company will ship 250,000 tons of cement into Chicago annually, D. S. Colburn, of the Chicago office, stated in speaking at a recent waterway hearing in that city.

This was the first definite indication made by a local industrial concern of planned use of the water route in freight and bulk shipments to Chicago.

2,500,000-Barrel Order Awarded Marquette by Illinois

The Marquette, Missouri and Dewey cement companies were awarded contracts on February 11 for 2,500,000, 139,000 and 122,000 bbl. of cement, respectively, by the Illinois Department of Public Works and Buildings.

The 2,500,000-bbl. order is the largest ever awarded to the Marquette company or to any other middle western manufacturer for delivery in twelve months, and is thought to be the largest on record in the industry.

Its contract will enable the Alpha plant at La Salle, Ill., to operate at normal capacity during the balance of 1932. Repairs were under way and planned improvements had not been completed but the plant was reopened and production resumed on January 25. All former employes were recalled.

South Dakota Plant Profit for 1931 Is $53,000

The South Dakota state cement plant at Rapid City made a net profit of $53,373.11 for 1931, E. E. Hartley, sales manager, reported to Governor Green on January 21.

Net profit for the first half of the year amounted to $54,510.74. A net loss of $1,137.63, after deducting depreciation costs, occurred in the second half, making the net profit $53,373.11.

Hartley's report said that because of the cement price war last year prices were reduced approximately 35 per cent. Under these conditions, he said, "We believe that the showing made during 1931 will be satisfactory to the commission."

The detailed report for July 1 to December 31 showed gross sales of $626,000 and gross profit from sales of $21,088.36. Selling expense of $19,933.39 left a profit of $1,544.97 and deductions for depreciation made the net loss $1,137.63.

Six Firms Get Indiana Highway Cement Contracts

Bids for 1,800,000 bbl. of cement for the 1932 highway program were let at Indianapolis on February 12 by the Indiana state highway commission to six organizations.

Lehigh was awarded a contract for 450,000 bbl.; Wabash, 150,000; Louisville, 400,000; Lone Star, 475,000; Marquette, 200,000, and Kosmos, 225,000.

Price cutting of smaller firms eliminated the Universal Atlas Cement company, with a plant at Buffington, Ind., from at least part of the contract, Col. A. P. Melton, northern district representative, announced.

Products of Hydration and Hydrolysis of Portland Cement

Verify Silicates as Two Major Components of Cement—Doubt Presence of Tricalcium Aluminate—Find Complex Slag-Like Mass as Third Component

By R. J. COLONY
Associate Professor of Geology, Columbia University, New York, N. Y.

This second installment of R. J. Colony's investigation of the constitution of portland cement completes Part I of the bulletin prepared by this investigator and D. L. Snader, author of Part II.

The first installment of Part I appeared in last month's issue. The next issue will take up Snader's study of the physical properties and characteristics of tricalcium silicate, dicalcium silicate, tricalcium aluminate, and dicalcium ferrite.—The Editors.

In the February installment of this paper the writer described the preliminary studies made in the course of this investigation for the purpose of gaining as much first-hand knowledge as possible regarding the chemically pure compounds of portland cement. In this installment the facts learned in those preliminary studies are applied to the case of commercial portland cements.

APPLICATION OF RESULTS IN THE STUDY OF PORTLAND CEMENT

According to the opinions of the majority of those who have made a study of its constitution, portland cement is composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, and perhaps a little 5.3 calcium aluminate.

Provided all of the alumina in portland cement is present in the form of tricalcium aluminate, that component comprises from twelve to twenty per cent of all normal commercial portland cements. If the iron is present as dicalcium ferrite, then from one-eighth to one-quarter of all portland cement consists of two components which disintegrate when immersed in water. But normal portland cement not only does *not* disintegrate when test pieces made from it are immersed in water, but such test pieces increase in strength. These discrepancies in behavior were noted by Bates[9], whose tricalcium aluminate test pieces failed when immersed in water. Bates observed that "tricalcium aluminate is apparently not a true hydraulic cement," and endeavored to find an answer to the question—"as to why portland cement, which contains approximately 20 per cent of this compound, does not show more of the characteristics of the latter" (tricalcium aluminate)—in the condition in which tricalcium aluminate occurs in cement clinker. Bates concluded that the components existing in cement clinker were minute in their crystallization and even in the finely ground product each grain was complex, so that the hydration behavior of the tricalcium aluminate was controlled and modified by the other components and by the gypsum added during the grinding of the clinker.

It is true that the components of portland cement are very minutely crystalline and that many of the grains are crystalline aggregates; it is this condition that renders the petrographic study of the finely ground commercial product so difficult and unsatisfactory. Unground portland cement clinker is somewhat easier to work with, but the individual components are so minute and so complexly intercrystallized that even the clinker fails to yield separate and distinct unit grains when it is crushed and studied microscopically.

Character of Glassy Mass

Petrographic examination of fragments of clinker mounted in appropriate immersion media, and of thin sections cut from the clinker is the only optical method of attack, however. Hundreds of cement samples and thin sections cut from clinker secured from different cement manufacturers have been examined by the writer during the past fifteen years; in none of these has it been possible to prove that tricalcium aluminate as such existed to the amounts of twelve to twenty per cent, or even to demonstrate with any certainty that it was present at all; nor was it possible to prove that dicalcium ferrite existed in the cements or clinkers. The prominent and constant crystal components in all of the clinker examined are the two silicates which are embedded in and surrounded by an indefinite, glassy or slag-like mass in which is distributed most of the iron, sometimes as excessively minute grains, separable and visible only with very high magnification, sometimes as an indefinite brown, very hazy stain that is not resolved even with high magnification. It is only occasionally that an iron component grain may be encountered that approaches dicalcium ferrite in optical properties. This same condition has been recently

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From Bulletin No. 4, Department of Civil Engineering, Columbia University, New York, July, 1931.

[9] Bates, P. H., Cementing Qualities of the Calcium Aluminates. Technologic Paper 197, Bureau of Standards, 1921.

observed by Gillson and Warren[10], who studied several different brands of clinker by the fragment method. Because of certain discrepancies in indices of refraction of one of the components (tricalcium silicate?) as compared with the index of refraction of pure tricalcium silicate prepared by Rankin and Wright[11], and because the optic angle of the other component in the clinker ($\beta 2CaO.SiO_2$?) was 20 deg. as contrasted with a "large" optic angle determined by Rankin and Wright for pure β dicalcium silicate, and because analyses of separated fractions proved them to contain lime, silica and alumina, Gillson and Warren suggest that the two major components of portland cement are calcium aluminum silicates of some sort, and that tricalcium silicate and dicalcium silicate do not exist in portland cement. We are not in accord with this interpretation, however, since a comparison of x-ray diffraction patterns of pure tricalcium silicate and pure dicalcium silicate with x-ray diffraction patterns obtained from portland cement clinker proves that both of these components, tricalcium silicate and dicalcium silicate, are present in the clinker; *but no x-ray diffraction patterns of any other crystalline substance could be obtained from the clinker.* This seems significant, particularly in view of the difficulty of identifying tricalcium aluminate in either cement or clinker, although if the alumina is present in that form there should be from twelve to twenty per cent of that component present. According to the studies of Hansen, Brownmiller and Bogue[12] a new compound not hitherto described, having a composition $4CaO.Al_2O_3.Fe_2O_3$, in which dicalcium ferrite ($2CaO.Fe_2O_3$) is soluble, occurs as one of the major components of portland cement.

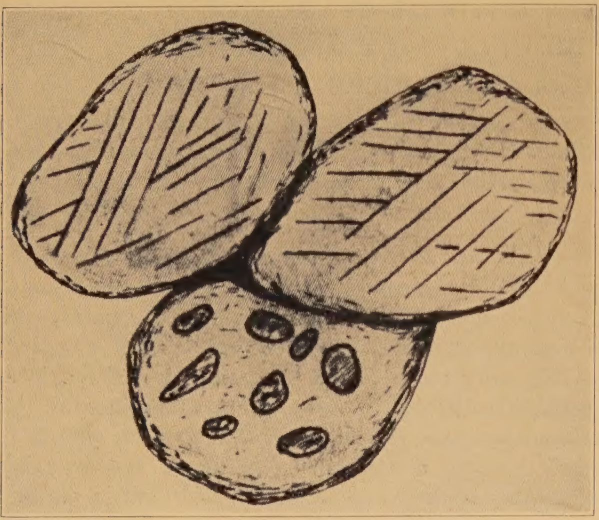

Figure 6. Drawing of group of dicalcium silicate grains in portland cement clinker, magnified 1,000 times

Provided all of the iron in the cement is combined in this form, an aliquot proportion of alumina would be used in the formation of the compound, leaving considerably less alumina existing as tricalcium aluminate. Provided the amount of tricalcium aluminate in portland cement is not more than from four to six per cent, it would be very difficult if not impossible to obtain a diffraction pattern of this compound from portland cement clinker, and still more difficult to obtain such a pattern from cement itself.

COMPONENTS IN PORTLAND CEMENT CLINKER

1. Tricalcium Silicate

The component in the clinker that may be referred to as tricalcium silicate occurs in colorless grains and prisms, and in groups of grains intercrystallized with β dicalcium silicate; both of the calcium silicates are embedded in a matrix that is slag-like or glassy, with which is associated the iron component.

The tricalcium silicate is frequently in good crystal form and often exhibits cleavage; it usually contains many inclusions, both crystal inclusions and vacuoles; occasionally twinning occurs in random grains. The birefringence is always very low, but the numerous minute rounded crystal inclusions have a stronger birefringence than the tricalcium silicate itself. (See Figures 7 and 8.)

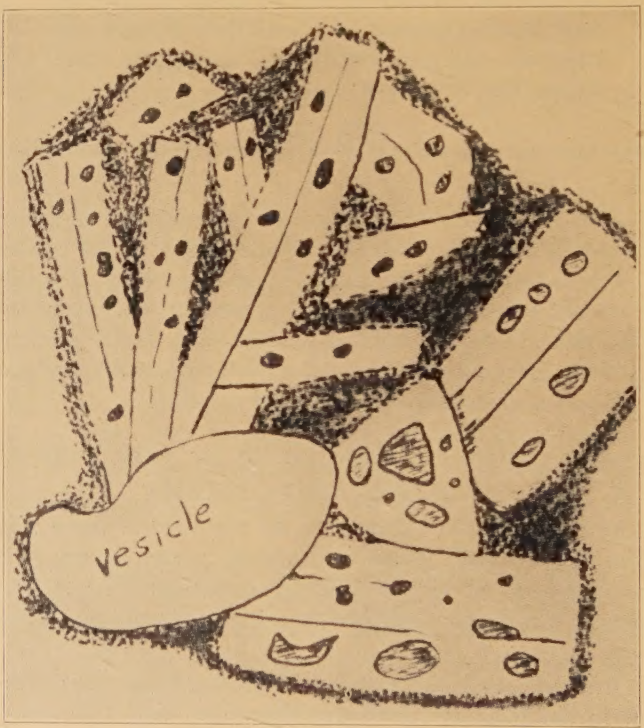

Figure 7. Drawing of euhedral tricalcium silicate crystals in portland cement clinker, magnified 1,000 times

Since this component hydrolyzes much more readily than dicalcium silicate it is usually the latter that forms the groups of unattacked residual grains of cement commonly found in concrete even after a lapse of years, and which is always found in multitudes of grains in portland cement test pieces. (See Figures 9, 10 and 11.) Tricalcium silicate is the component that furnishes much of the calcium hydroxide which crystallizes mixed with

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[10] Gillson, Joseph L., and Warren, Elmer C., A Preliminary Petrographic Study of Portland Cement. *Journal* of the American Ceramic Society, Vol. 9 (12), 1926.

[11] Rankin, G. A., and Wright, F. E., The Ternary System $CaO-Al_2O_3-SiO_2$. *Am. Jour. Sci.*, Vol. 39 (4), 229, Jan., 1915.

[12] W. C. Hansen, L. T. Brownmiller, and R. H. Bogue, Studies on the System Calcium Oxide-Alumina-Ferric Oxide; Paper No. 13, Co-operative Investigations by the Portland Cement Association and the National Bureau of Standards, February, 1928.

"leucocol," and which in solution likewise is removed from concrete structures subjected to percolating water, due to the very slow but continued hydrolysis of the incompletely hydrolyzed components of the cement. It is conceivable that slow, continuous hydrolysis of the cement components, with removal of calcium hydroxide in solution in percolating waters, might result ultimately in complete hydrolysis of the cement components and consequent weakening of the structure. Calcium hydroxide thus removed from the cement of concrete structures manifests itself as unsightly white patches of calcium carbonate around construction joints or as stalactites of calcium carbonate pendant from tunnel roofs, and as white coatings on nearby rock that may lie immediately in front of and at the foot of concrete dams. It likewise frequently

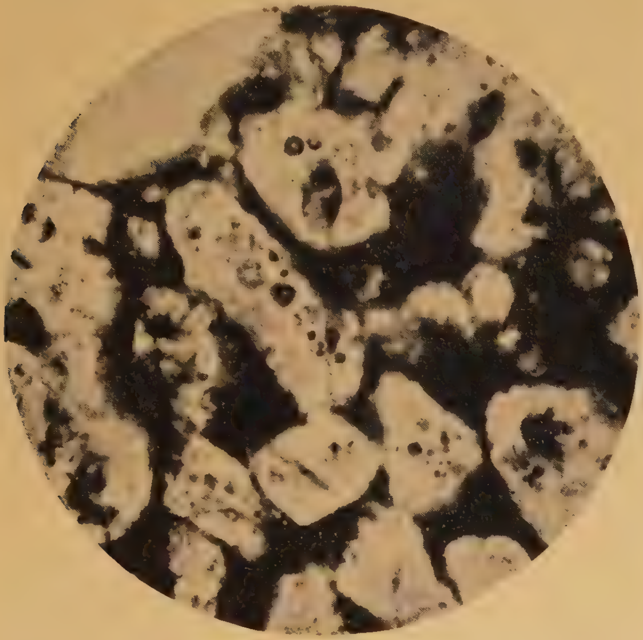

Figure 8. Light gray individual crystals of tricalcium silicate in cement clinker distributed through a very dark matrix. Magnified about 700 times

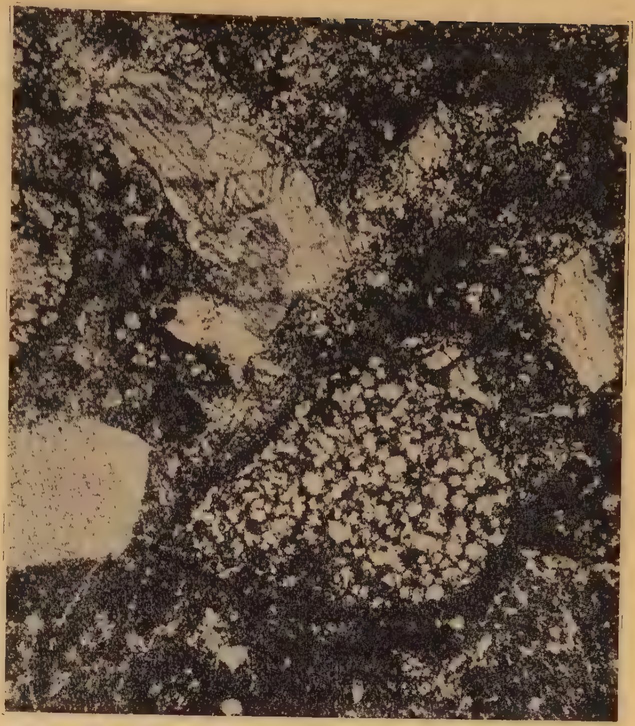

Figure 10. Sample of 31-year-old concrete from bridge. Note large fragments of non-hydrolyzed residual clinker, composed of clusters of dicalcium silicate grains with an occasional crystal of tricalcium silicate mixed with them. Magnified 200 times

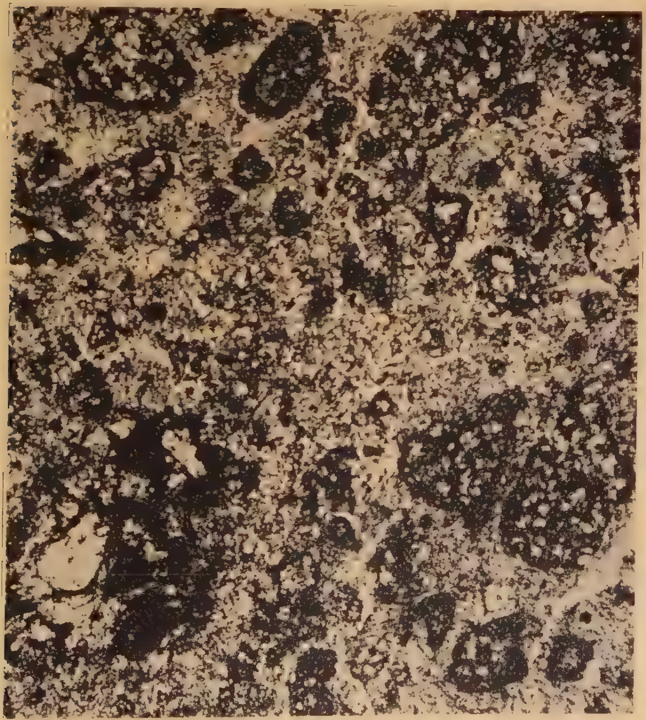

Figure 9. Sample of hardened cement taken from unused bag left exposed out of doors for one year. Note residues of partially hydrolyzed and non-hydrolyzed clinker, principally groups of dicalcium silicate grains. Magnified 200 times

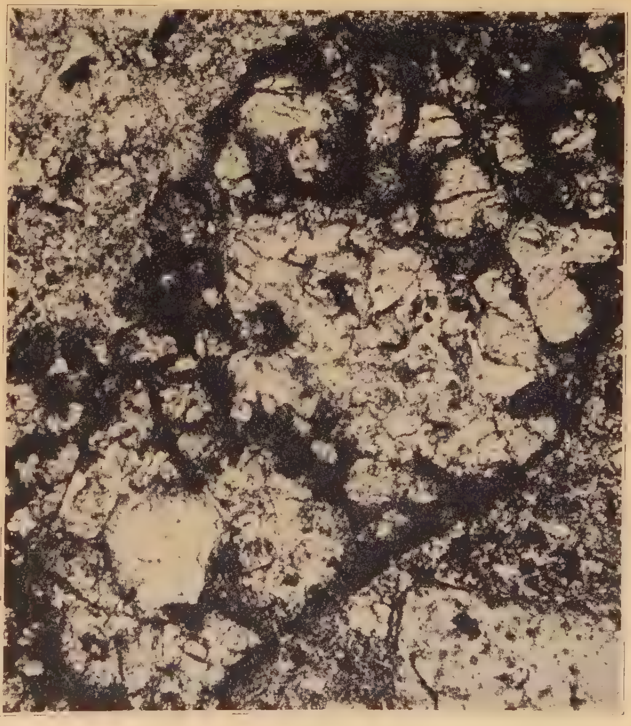

Figure 11. Sample of concrete from 40-year-old structure. Note the extremely large fragment of essentially non-hydrolyzed clinker. It contains all three major components of cement. Magnified 200 times

appears on the face of concrete walls and other concrete structures wherever the porosity of concrete permits percolating water to seep through the structure and dissolve the liberated calcium hydrate, which as calcium carbonate precipitates on outer surfaces exposed to the air, regardless of the existence of construction joints. (See Figure 9.)

2. Dicalcium Silicate

This component occurs in portland cement clinker in groups of spherical grains, frequently intercrystallized with tricalcium silicate but also in clusters by itself, embedded in and surrounded by the same dark, brownish iron-carrying glassy or slag-like component that serves as a matrix for the tricalcium silicate.

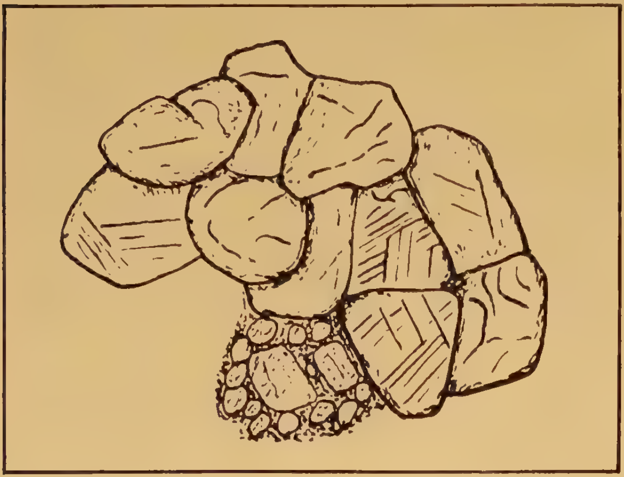

Figure 12. Drawing of cluster of dicalcium silicate grains in cement clinker, magnified 650 times

Dicalcium silicate in portland cement clinker varies in color from greenish-brown to brownish-green; the color is always very decided, so that this component is in strong contrast with the colorless crystals of tricalcium silicate. Fine complex twinning is a very common feature (see Figures 6 and 12) so that it is possible that both *alpha* and *beta* forms of dicalcium silicate are common in all clinkers. The color of these grains is suggestive of the presence of more or less iron, and as the color varies in different clinkers it is not surprising that there should be slight variation in the optical constants as well, since indices of refraction, optic angles and birefringence all vary with slight variation in composition of the same material.

The birefringence of these grains ranges from 0.010 to 0.025 in different clinkers, dependent in part on the orientation of the grain and in large part on the differences in composition, such differences being probably due to variation in the amount of the constituent that imparts color (iron?) to the grains. Some of the grains carry crystal inclusions, but these are not common.

Since this component hydrolyzes much more slowly than tricalcium silicate, clusters of dicalcium silicate grains, frequently carrying a few crystals of tricalcium silicate, occur in large numbers in cement test pieces, and were also found in the cement of concrete structures, as unattacked residual clinker fragments. (See Figures 9, 10 and 11.)

The tricalcium silicate crystals intercrystallized with clusters of dicalcium silicate grains seem to have been protected from attack by the more resistant grains of dicalcium silicate which surround them. Such groups of residual clinker fragments may remain unacted on in concrete structures for many years (see Figure 11), but on the other hand residual groups of unhydrolyzed clinker in many concrete structures, especially when the concrete is exposed to slowly percolating water, ultimately hydrolyze completely in place, leaving mere "ghosts" of the grains whose forms, and frequently structures, are preserved but whose substance has been completely changed, in some cases to an isotropic gel, in other cases to carbonate.

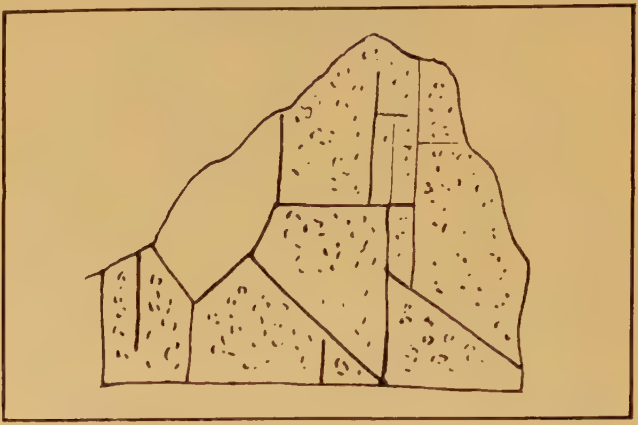

Figure 13. Drawing of crystal of lime (CaO) in cement clinker, magnified 650 times

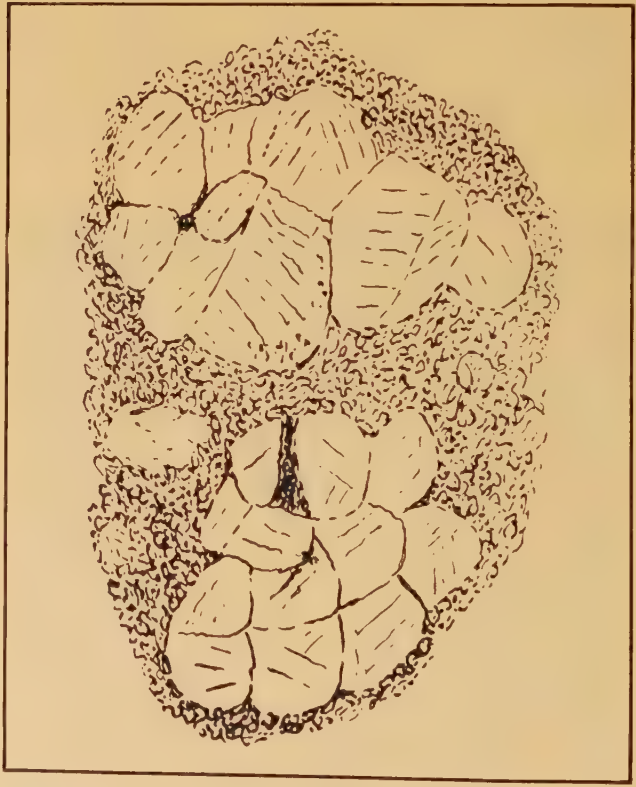

Figure 14. Drawing of "ghosts" of residual clinker in concrete 18 years old, magnified 500 times. Only the form of the dicalcium silicate grains remains

Such a case is represented in Figure 14, drawn from a thin section of concrete taken from a structure erected eighteen years ago. The group of dicalcium silicate grains, in a fine ground mass of products of hydrolysis, retains the forms of the grains and to some degree their original structure but between crossed nicols all structures and forms vanish; the fine ground mass and the "ghosts" of the grains prove to consist of finely granular carbonate mixed with a little gel-like isotropic matter.

Samples from many concrete structures exhibit similar features, so that it seems reasonable to conclude that very slow, but continuous hydrolysis may operate over long periods of time in concrete structures subjected to the action of slowly percolating water. Precipitation of the lime hydrate (in solution) as calcium carbonate does not usually extend to more than a few inches into the mass of the concrete; it is only the extreme outer skin of the structure that is so affected.

It is also conceivable that the persistent, continued slow seeping of water through concrete may in time effect complete destruction of the components of the cement with the production of gels composed of silica, hydroxide of alumina and hydroxide of iron, with consequent weakening and softening of the concrete.

3. The "Third Component"

In addition to the two major crystalline components of cement clinker, the calcium silicates just described, there is an indefinite glassy or slag-like dark colored substance that acts as a matrix for the crystalline silicates, and which carries most of the iron and probably the greater part of the alumina also, since we have not been able to prove that much of the alumina in portland cement clinker exists in the form of tricalcium aluminate.

Törnebohm[13] called this substance "celite," and regarded it as an easily fusible mixture that promoted the crystallization of "alite." Campbell[14] endeavored to separate this readily fusible substance from the less fusible crystalline components by absorption in magnesia discs. He concluded that the fusible portion, the "celite" of Törnebohm, consisted of a calcium aluminate of unknown composition, capable of dissolving iron oxide, lime and calcium orthosilicate, a $CaO.SiO_2$, regarded as "alite" by Campbell. Analyses of the fusible "celite" absorbed by the magnesia discs proved that it was made up of silica, alumina, lime and ferric oxide.

Bogue[15] and his co-investigators believe this "third component" to be a definite ternary compound, $4CaO.Al_2O_3.Fe_2O_3$. They have made this compound, and have determined its optical constants. When, however, one works with either portland cement clinkers or cement made from the clinker, the "third component" does not exhibit the clear cut optical characters, assigned to the compound $4CaO.Al_2O_3.Fe_2O_3$ by the authors just cited. On the contrary, the "third component" is not distributed in individual grains, like the two calcium silicates. It is interstitially distributed, coating and enveloping practically every determinable grain. It varies in color in different clinkers and even in various clinkers of the same heat, from light yellowish red to brown, and even to very dark brown. It carries occasional clear red-brown grains that are birefringent, but in mass it is commonly isotropic, although it is possible to observe birefringence in some cases provided very high magnification and strong light is used. It appears as a stain and rarely as isolated grains that are themselves made up of excessively minute dark brown granules; it is very clearly complex in composition and variable in its make-up.

This substance, representing the "third component" of the writers and probably the "ternary compound" of Bogue et al. is apparently the most fusible portion of the clinker; it is variable in composition and, as suggested by its color, carries certainly the greater part of the iron and possibly much of the alumina, and some lime as well, although its exact composition cannot be determined because the individual components in the clinker cannot be separated for the purpose of chemical analysis; they are too intimately intermixed.

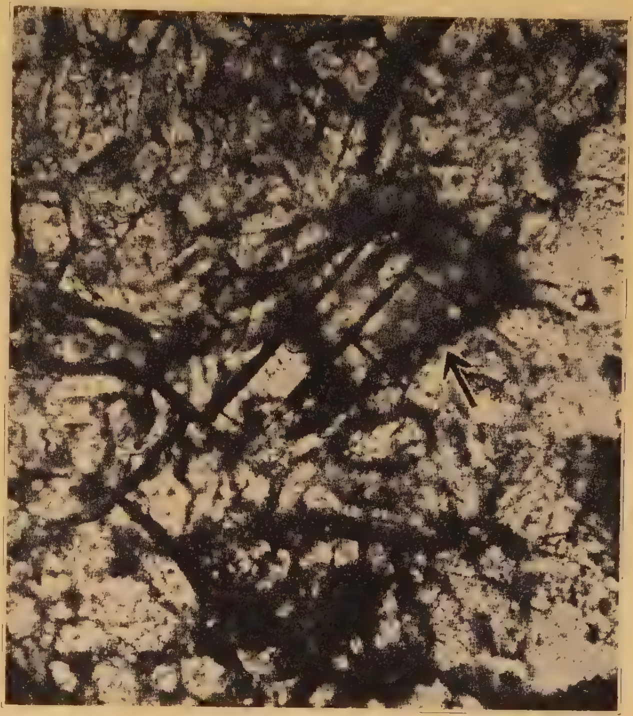

Figure 15. Sample of portland cement clinker, magnified 300 times, showing a crystal of lime (CaO) with strong cleavage embedded in and surrounded by crystals of tricalcium silicate

4. Minor Components

(1) *Glass*, of unknown composition, is common in most clinker in very small amounts. It is usually clear and transparent, slightly greenish or brownish in color, and sometimes carries arborescent crystallites within itself. It may be found occasionally in concrete and in cement test pieces, usually associated with fragments of residual clinker in the concrete. It has no significance in cement, except as evidence that portland cement clinker is not a holocrystalline product.

(2) *Lime Crystals.* Very rarely crystalline lime (CaO) is encountered in cement clinker, usually in clinker relatively high in lime and with a minimum silica content. The crystals are colorless and isotropic, with high relief

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[13] Tornebohm, *Tonindustrie Z*, 21, 1148 (1897).

[14] Campbell, Edward D., Constitution of Portland Cement Clinker. *Journ. Ind. and Eng. Chem.* 5, 1913, pp. 627-630.

[15] W. C. Hansen, L. T. Brownmiller and R. H. Bogue, Studies on the System Calcium Oxide-Alumina-Ferric Oxide. Paper No. 13, Co-operative Investigations of the Portland Cement Association and the National Bureau of Standards, February, 1928.

and strong cleavage (see Figures 13 and 15). Although many freshly made cements and freshly burned clinker will give a test for free lime with White's reagent,[16] lime crystals are very seldom encountered in the clinker, and rarely will test pats made from a normal portland cement fail because of the presence of free lime, since the very small quantity of uncombined lime existing in cement usually hydrates readily and completely during the interval of time that commonly elapses between the manufacture and packing of the cement and its use.

(3) *Other Rare Components.* Occasionally random grains may be observed in clinker, and even in the residual fragments of non-hydrolyzed clinker in concrete and in cement test pieces, that do not respond to the optical tests for calcium silicates or for tricalcium aluminate. Such, for example, as the 3:5 aluminate ($3CaO.5Al_2O_3$), which occurs in sporadic grains in many cements. None of these minor components has any bearing on the quality or behavior of cement, since they exist in such minute proportions that they can exert no control.

SUMMARY

1. The two major crystalline components of portland cement are judged to be dicalcium silicate and tricalcium silicate.

The tricalcium silicate contains many crystal inclusions which may possibly contain part of the alumina in some form.

A third complex and variable, slag-like and indeterminable dark-colored interstitial mass acts as another component. Most of the iron, and perhaps alumina, with both lime and silica (complex slag?) make up this component, which behaves as a matrix in which the two major crystalline components are distributed.

Tricalcium aluminate as such could not be definitely identified, although if all the alumina in normal portland cements were present in that form, from 12 to 20 per cent of the cement would consist of a quantity of tricalcium aluminate which should be readily identified in cement clinker.

2. The two calcium silicates hydrolyze with the formation of the same products of hydrolysis, calcium hydrate and hydrated gel-like calcium silicate. Tricalcium silicate hydrolyzes much more readily, yielding more calcium hydroxide in the process than dicalcium silicate.

The "third" indefinite component hydrolyzes also, producing hydrated products carrying both iron and alumina.

3. The marked, rapid disintegration of test pieces made of tricalcium aluminate when immersed in water, indicates that tricalcium aluminate, as such, may not exist as one of the important components of portland cement. The alumina may occur in some other form, perhaps in the "third" complex component as suggested. It does not seem logical that from twelve to twenty per cent of tricalcium aluminate in cement should be so modified in behavior by reason of fine intercrystallization with the other components that it would exert no destructive action in cement, even when neat test pats are subjected to boiling.

4. When concrete structures are subjected to intermittent or constant, slow, and long-continued percolation of water, as in a dam, the components of the cement may completely hydrolyze, because the continued removal of one of the products of hydrolysis, calcium hydroxide, by solution and precipitation as crystalline calcium hydroxide, or as calcium carbonate, permits the action to go on; and under such conditions concrete frequently softens and disintegrates.

5. Standard portland cements differ in chemical composition within very narrow limits; consequently they all contain the same components. The components vary in proportions in different cements, the variation being dependent on the narrow range of variability in chemical composition. The products of hydrolysis of all portland cements are accordingly substantially the same; but they, likewise, differ in proportion; and perhaps the degree of hydrolysis will differ, dependent on factors that are connected with making, mixing and placing the concrete of which the cement is one ingredient.

(To Be Continued)

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[16] White, Alfred H.. Free Lime in Portland Cement. *Journ. Ind. and Eng. Chem. I*, 1909, pp. 5-11.

Tan Portland Cement Announced by Pacific Portland

The Pacific Portland Cement Co. has announced a new process for producing a tan portland cement.

"The new process marks the first real improvement in the basic color of portland cement since its discovery 108 years ago, according to Robert B. Henderson, president of the company," the announcement, which has been given national publicity, states.

It is a true portland cement guaranteed to pass the requirements of the A. S. T. M., and may be used in work such as stucco, cast stone, monolithic concrete, tennis courts, swimming pools, driveways, sidewalks, and floors and walls.

North Carolina Awards Highway Cement Contracts to Eight Plants

Contracts have been awarded by the State of North Carolina for 1,600,000 bbl. of cement, orders going to eight firms.

Each of the following was awarded contract for 200,000 bbl.: Lehigh, Allentown, Pa.; Universal Atlas, Philadelphia; Lone Star Cement, Norfolk; Signal Mountain, Chattanooga; Alpha, Birmingham; Penn-Dixie, Chattanooga; National, Birmingham, and Volunteer Portland Cement Company, at Knoxville.

Manitowoc Resumes; Anticipates Full-Time Operation

The Manitowoc Portland Cement Co. resumed operations on February 1 and is now operating on about two-thirds time. It is expected that the plant may be on a full-time basis within a short time.

Hundred Start Work at Cumberland Plant

The Cowan, Tenn., plant of the Cumberland Portland Cement Co. resumed operations early in February, giving employment to about 100 men.

EDITORIAL

True Value of Laboratory Experiments

SOME facts learned in a laboratory can be applied to the practical needs of concrete construction and cement manufacture; but for the most part it is a mistake to assume that laboratory facts tell the ultimate story. Such erroneous assumptions often lead to the necessity for retracing steps that represent much financial outlay.

Even manufacturers of cement mill equipment, after spending much time and money in the development of a new or improved unit, usually find it necessary to make numerous changes and adjustments when the equipment is given a test run under the actual conditions encountered in factory production.

Long ago the chemical industry learned this lesson. In that industry the customary procedure is to try out a new idea or a new process with laboratory-size equipment, with the view of determining some of the basic facts. Next a semi-plant is built, and provided with testing equipment about half the size of corresponding commercial equipment, for the purpose of determining whether the new idea or process is practicable on a commercial scale.

Investigations conducted on this broad scope require co-operation within an industry, and the liberal expenditure of funds; and in most cases the truth can not be found unless the industry is willing to make these expenditures.

Laboratory investigations alone may establish certain basic principles, but that is the limit of their usefulness. They can not, as a rule, approach closely enough to the conditions found in commercial production to justify full acceptance of the results.

Tan-Colored Cement

A CEMENT manufacturing company has announced a new product, a tan-colored standard portland cement. The new color is produced, not by the addition of coloring matter subsequent to calcination, but in the burning process itself.

The expectation of the manufacturer is that the new product will find its market in stucco work, in cast stone, in monolithic architectural concrete, in colored walks and drives, and in numerous other locations where the color effects that can be produced will be an asset.

To an observer looking at the entire cement industry the announcement of this tan-colored cement represents much more than the appearance of a new product. First of all, it probably represents the expenditure of much time and money in the research and experimentation that finally produced the new material. It represents the consummation of an effort to stimulate demand by producing something that possesses a new attractiveness—something that within itself constitutes a special inducement to the buyer. It also constitutes a stimulant to the chemists of the cement industry, for it proves once more that there is no "last word" in cement manufacture.

By the time that the coming decade is half gone we shall probably look back on the appearance of this colored cement as one of the first of a series of new products and processes which, taken collectively, will have all but revolutionized the cement industry.

Reducing the Delivered Cost

IN spite of the importance of lower production cost, this is not the only way in which the cement manufacturing industry may reduce the delivered cost of its product.

The cost of distribution may offer opportunities for reduction, perhaps equal in magnitude to the reductions effected in recent years in production costs. Many cement company managements are fully alive to these opportunities, as evidenced by the increasing use of water transportation in conjunction with well-equipped storage terminals designed to facilitate handling, the use of specially designed railway cars for transporting and delivering cement in bulk, and more recent experiments with the railway shipment of bulk cement in large containers.

Greater continuity of employment is another problem with which the industry has long been wrestling. These efforts, up to the present time, have been confined largely toward the shortening of the winter shutdowns; but in the light of experiences gained in some other industries during the past two years, as well as several notable examples in the cement industry itself, cement executives may well devote more thought to other expedients. Among these are shorter working hours per man per day, shorter working weeks in certain departments, and rotation of employment, all to be applied to an increasing extent as the plant operations slow down. Through these methods of improving employment distribution, cement companies will not only aid themselves because of the lower labor turnover, but they will contribute toward the solution of a great national problem.

Still other ways can be found to reduce the cost of cement at the point of delivery to the consumer. Most assuredly, reduced production cost is not the only means available.

High-Quality Cements No Monopoly of Large Production Units

Composition of Raw Materials of Less Importance Than Fineness and Uniformity—Test of Uniformity—High Early Strength with Normal Lime Content

By E. LEDUC
Honorary Chief of Section of Materials of Construction of the
National Conservatory of Arts and Trades, Paris

(Continued from February Issue)

THE previous installment of this series contains a discussion of the need for a competent technical staff in the cement plant of ordinary size, and several cases are cited where cements of very high strength were made in very small plants. Raw materials were also discussed.

In this installment raw materials and the meaning of their characteristics will be discussed still further, in considerable detail.

Hydrochloric Acid Treatment

Some experiments now quite old (on the constitution of limestone, made in 1907) have shown in a visual manner the difference in the homogeneity of a great number of marly limestones. This method consists, as several investigators had applied it before that time in the laboratory of the Societe Pavin de LaFarge, of treating with a weak solution of hydrochloric acid the carefully planed surface of a small disc of limestone. After some days, one could perceive some small pit-craters wherever the lime predominated, and, on the contrary, some tiny nipples wherever there was an excess of clayey material. Since then, this method has been perfected by immersing the limestone, previous to the treatment by the acid solution, in a bath of boiling paraffin, in order to give some degree of firmness to the clayey portion.

Chemical Composition Same, But Results Differ

Through this procedure it is easy to see how certain limestones having the same average chemical composition are, nevertheless, much different.

Let us assume, for illustration, a limestone composed of an agglomeration, on the one hand, of small spheres of pure carbonate of lime 10 m/M in diameter, and, on the other hand, of similar spheres of pure clay. Then, assume another limestone composed of the same material, but in which the spheres are only one-tenth of a millimeter in diameter.

If, in each of these two cases, the percentages of carbonate of lime and of clay are equal, it is evident that a chemical analysis will give the same results. Based on this sole analysis, one will draw the erroneous conclusion that these two limestones have the same value for the manufacture of cement. However, after burning, the first will yield only a useless heap of quick-lime and some burned clay, whereas the second will produce cement rock.

When tested as described above by a solution of hydrochloric acid, the first of the above limestones will show a surface composed of small cavities, wherever the carbonate of lime occurred, while the small spheres of clay will remain intact. One will therefore have a succession of cavities and small nipples. In the second case, because of the small size of the grains, the surface will be attacked uniformly and will show neither cavities nor nipples. This test shows the difference between these two limestones from the standpoint from which we are interested.

Procedure for Test of Uniformity

It is likewise possible to establish the homogeneity of a limestone through the following procedure:

Take a test specimen of the limestone 8 or 10 cm. in dimensions, then drill vertically one or more holes with a drill-brace fitted with a wood drill, striving to advance the bit by only a very small amount at each turn of the brace, so as not to remove more than a single disc weighing a maximum of 1 gr. Determine the proportion of clay in each of the successive samples taken out.

The limestones given in Table 4, which were tested by this method, indicated some peculiarly interesting results. In this experiment we made three borings within 3 cm. of each other, in specimen No. 1804.

Great Variation in Short Distance

The results given by this test, notably with specimen No. 1804, are quite typical. Here it is seen that at a horizontal distance of 2 or 3 cm., and very close to the same depth, the strata are quite different. For instance, in boring No. 1 of specimen No. 1804 one stratum contains 20.01 per cent of clay, whereas in boring No. 2 the stratum encountered at the same depth contains only 14.94 per cent.

These tests, like those made by treatment with hydrochloric acid, show that the limestone specimen No. 1831 is composed of a quite homogeneous mass, while the other specimens, and especially No. 1804, are not so.

The illustration, taken from a photograph of specimen No. 1827, is quite characteristic.

While it is always interesting to check a chemical analysis by a test of homogeneity in the case of raw material for the manufacture of portland cement, it is absolutely

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Translated from *Le Ciment* (Paris), November, 1931.

TABLE 4

Percentage of Clay in Samples Drilled from Limestone

	Specimen No. 1804			Spec. No. 1814	Spec. No. 1827	Spec. No. 1831
	Boring No. 1	Boring No. 2	Boring No. 3			
No. of core samples	20	15	15	18	18	28
Percentage of clay	17.35	15.17	15.67	19.32	17.67	14.25
	19.14	15.01	14.80	19.08	18.25	15.84
	20.01	14.94	14.82	19.14	18.60	15.04
	18.30	15.03	15.52	19.78	18.10	14.84
	18.67	14.67	15.46	20.45	17.80	14.50
	15.76	15.38	15.48	21.01	17.96	15.52
	17.42	15.77	15.51	20.03	17.77	14.33
	15.55	15.89	15.48	20.00	17.47	14.94
	18.52	16.69	16.25	20.76	17.12	14.82
	19.13	16.13	16.07	20.58	16.38	14.58
	18.58	14.99	15.59	20.47	16.00	14.93
	18.14	14.99	15.71	20.33	15.62	14.99
	15.39	15.09	15.62	20.15	15.12	15.02
	17.62	15.25	15.43	19.88	14.99	14.91
	18.95	15.11	15.29	19.40	15.30	14.99
	20.37	-------	-------	18.91	15.41	15.24
	17.06	-------	-------	19.10	15.85	15.18
	18.85	-------	-------	18.87	15.93	15.15
	21.90	-------	-------	-------	-------	15.09
	20.23	-------	-------	-------	-------	15.08
	-------	-------	-------	-------	-------	14.35
	-------	-------	-------	-------	-------	14.96
	-------	-------	-------	-------	-------	14.86
	-------	-------	-------	-------	-------	14.61
	-------	-------	-------	-------	-------	14.64
	-------	-------	-------	-------	-------	14.47
						14.34
	-------	-------	-------	-------	-------	14.28
Maximum	21.90	16.69	16.25	21.01	18.60	15.84
Minimum	15.39	14.67	14.80	18.87	14.99	14.25
Differences	6.51	2.02	1.45	2.14	3.61	1.59

necessary to conduct this test as a means of studying limestones intended for the manufacture of natural cement.

High Lime Content Not Necessary

Aside from the conditions of stability, time of set, shrinkage, and bonding strength, the resistance of a cement to mechanical abrasion must also be as high as possible. It is the current belief that, in order to obtain high strength, it is absolutely necessary to manufacture cement containing a high proportion of lime. In so far as we have observed, we do not think that an excess of lime is always indispensable. The fineness and the uniformity of the raw mixtures are matters of more importance.

TABLE 5

Chemical Analysis Determined from Four Tests of High-Early-Strength Cement from Swiss Plant

	Per cent			
	Test No. 1	Test No. 2	Test No. 3	Test No. 4
Silica	20.50	20.70	20.05	20.65
Alumina	5.35	5.60	6.85	5.65
Iron oxide	2.35	2.25	2.60	2.40
Lime	62.10	61.60	62.40	62.40
Hydraulic coefficient	2.20	2.15	2.11	2.17
Silica coefficient	2.67	2.63	2.10	2.56

TABLE 6

Chemical Analysis Determined from Four Tests of High-Early-Strength Cement, Source Not Disclosed

	Per cent			
	Test No. 1	Test No. 2	Test No. 3	Test No. 4
Silica	21.25	24.00	24.20	24.96
Alumina	7.05	8.05	4.04	8.80
Iron oxide	3.00		3.70	
Lime	64.45	63.90	63.10	62.05
Hydraulic coefficient	2.08	1.99	1.97	1.84
Silica coefficient	2.09	3.00	3.11	2.83

High-Early-Strength With Ordinary Lime Content

Upon examination of the chemical composition of a high-strength cement produced by a Swiss plant which may be considered in the class of high-early-strength cements, it is seen, as the analyses in Tables 5 and 6 show, that the high early strengths are not due to an excess of lime. Table 6 gives the chemical analysis of cement from another plant of undisclosed location.

The average analysis of cement from the Swiss plant is:

Silica	20.5 per cent
Alumina	5.6 per cent
Iron oxide	2.4 per cent
Lime	62.1 per cent

Multiplying the silica content by 2.8, the alumina content by 1.65, and the iron oxide content by 1.0, and adding the products, the possible quantity of lime would be 69.04 per cent, whereas what it actually contains is 62.10 per cent.

The chemical analysis of the cement from this factory, like that coming from two other plants, is therefore entirely normal. It is practically the same as other high-early-strength cements at present being produced in a number of plants.

Hydraulic and Silica Coefficients

We also have before us some analyses in which the hydraulic coefficient is a little below 2, and others in which the silica coefficient is barely in excess of 2.

High-Early-Strength Cement from Shaft Kilns

We ourselves have manufactured some cement which readily attains high early strength, in a plant equipped with five automatic shaft kilns. The hydraulic coefficient and the silica coefficient were a little below 2. This cement had the composition shown in Table 7.

TABLE 7

Analysis of Cement from Plant Equipped with Shaft Kilns

	Per Cent	*Two Separate Tests*
Silica	21.00	22.15
Alumina	7.40	8.40
Iron oxide	3.10	3.10
Lime	61.18	61.30
Magnesia	1.58	1.45
Sulphuric anhydride	2.12	1.98
Loss by ignition	3.20	2.60
Hydraulic coefficient	1.99	1.87
Silica coefficient	1.92	1.84

The cement of which the analysis is given in Table 7, in 1:3 mortar briquettes, had 3-day strengths ranging from 476 to 548 lb. per sq. in., and 7-day strengths from 583 to 605 lb. per sq. in.

Lower Strength With High Hydraulic Coefficient

In contrast to the results recorded in Table 7, let us take the case of a cement plant where the raw materials were a very soft clayey limestone and an extremely friable marl which crumbled very easily. The composition of these materials was as follows:

	Limestone	*Clayey Marl*
Silica	8.30	26.00
Alumina	2.25	4.95
Iron oxide	1.05	2.05
Lime	48.25	32.50

These materials contained neither magnesia nor sulphuric anhydride, and the silica was wholly soluble. Under these conditions there was no difficulty about producing a cement with a high hydraulic coefficient. The cement gave the following analysis:

	Per Cent
Silica	22.50
Alumina	5.00
Iron oxide	2.18
Lime	68.30
Hydraulic coefficient	2.30
Silica coefficient	3.10

As will be seen, the quantity of lime is in the neighborhood of the amount necessary (73.43 per cent) to transform into tricalcium combinations all of the silica, the alumina, and the iron oxide.

When ground immediately after burning, the cement showed not more than 3 m/m of expansion at 100 deg. C. The strength of 1:3 mortar briquettes was 263 lb. per square inch in 3 days, 420 lb. in 7 days, and 523 lb. in 28 days.

This cement, with a high hydraulic coefficient, nevertheless showed less strength than the cements previously mentioned, in which the hydraulic coefficient was much lower.

Limestone specimen No. 1827, the clay analysis of which is given in Table 4

(To be continued)

Production Resumed at Richard City Plant of Penn-Dixie

The Pennsylvania-Dixie Cement Corp. plant at Richard City, Tenn., was to resume operations about March 1, after having been closed down since September.

High-Early-Strength Cement with 55 Pounds of Coal

A well known American cement plant engineer recently returned from Russia after having been engaged for several years in the design and construction of cement plants in that country. During the course of his work abroad he made a comprehensive investigation of cement plants and cement manufacturing processes throughout Europe.

Beginning in a series of articles in the April Cement Mill Edition of "Concrete" he will tell what he saw and learned.

"Back in 1927," he says, "I made the statement that the fuel cost was the largest single item of cost, and should be the one to receive the greatest attention. That is still true. While in Europe I saw some things that will give the American cement industry something to think about. I saw eight or nine plants making a hard burned clinker, and even high-early-strength cement, with less than 55 pounds of coal per barrel of clinker. Some are running below 50 pounds.

"This is accomplished in rotary kilns of less than the customary length used in our own plants.

"You printed an article about this process in the September (1931) issue, but that article failed to emphasize the point that the process described has been developed in a really practical manner and is in use in about ten plants. The commercial application of this process under American conditions will show a saving of 6 to 10 cents per barrel when compared with the best results attainable with long rotary kilns and waste heat boilers."

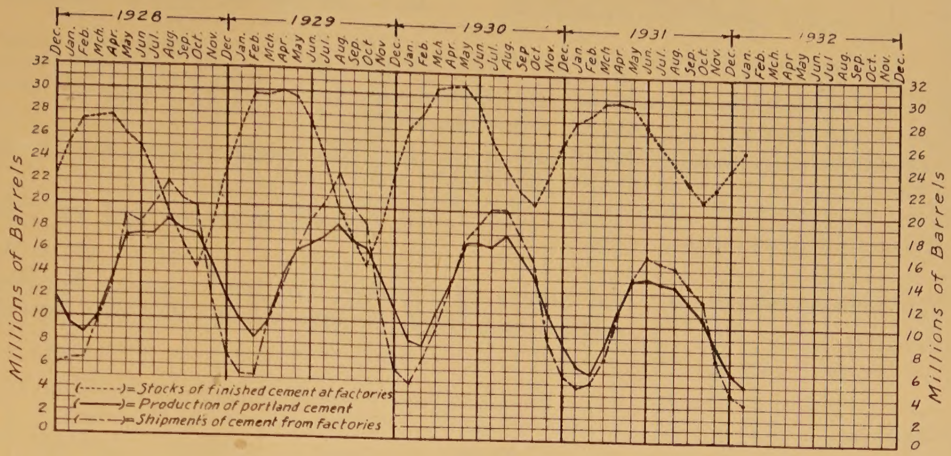
High-early-strength cement with 55 pounds of coal per barrel of clinker is something well worth the hardest kind of thinking. It is therefore especially fortunate that the Cement Mill Edition of "Concrete" is able to present to its readers this interesting series.

Cement Statistics for January

Effect of Extensions and Improvements Seen on Capacity

Relation of Production to Capacity

	The Month, Per Cent	The Twelve Months, Per Cent
January, 1932	22.0	45.9
January, 1931	**29.5**	**60.6**
December, 1931	26.4	46.5
November, 1931	37.2	44.4
October, 1931	47.4	48.6



	1931	1932	Increase or Decrease, %
Production, January	**6,595,000**	4,989,000	—24.4
Shipments, January	**4,692,000**	3,363,000	—28.3
Stocks at end of month	**27,759,000**	25,568,000	—7.9

	1931	1932	Increase or Decrease, %
Total production for yr.	(Same as first item)		....
Total shipments for yr.	(Same as second item)		....
No. of plants reporting	165	165	0

Production, Shipments, and Stocks of Finished Portland Cement, by Districts, in January, 1931 and 1932, and Stocks in December, 1931 (In Barrels)

District	Production—January 1931	Production—January 1932	Shipments—January 1931	Shipments—January 1932	Stocks at end of month 1931	Stocks at end of month 1932	Stocks at end of December, 1931*
Eastern Pa., N. J. and Md.	**1,617,000**	1,511,000	**1,084,000**	1,073,000	**5,546,000**	5,212,000	4,774,000
New York and Maine	**420,000**	279,000	**206,000**	199,000	**1,988,000**	1,423,000	1,343,000
Ohio, Western Pa. and W. Va.	**504,000**	246,000	**367,000**	239,000	**3,709,000**	3,477,000	3,470,000
Michigan	45,000	**164,000**	**220,000**	121,000	**2,915,000**	2,099,000	2,057,000
Wis., Ill., Ind. and Ky.	**804,000**	540,000	**354,000**	237,000	**3,955,000**	3,120,000	2,817,000
Va., Tenn., Ala., Ga., Fla. and La.	**646,000**	425,000	**679,000**	404,000	1,766,000	**1,817,000**	1,796,000
Eastern Mo., Ia., Minn. and S. Dak.	**854,000**	534,000	**288,000**	142,000	**3,069,000**	823,000	3,098,000
W. Mo., Nebr., Kans., Okla. and Ark.	450,000	**530,000**	**321,000**	194,000	**2,218,000**	1,817,000	1,481,000
Texas	322,000	**338,000**	**340,000**	241,000	782,000	**823,000**	726,000
Colo., Mont., Utah, Wyo., and Idaho	**123,000**	39,000	**50,000**	33,000	410,000	**486,000**	480,000
California	**624,000**	336,000	**643,000**	413,000	831,000	**1,154,000**	1,231,000
Oregon and Washington	**186,000**	47,000	**140,000**	67,000	570,000	**640,000**	669,000
	6,595,000	4,989,000	4,692,000	3,363,000	27,759,000	25,568,000	23,942,000

Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1931 and 1932 (In Barrels)

Month	—Production— 1931	—Production— 1932	—Shipments— 1931	—Shipments— 1932	Stocks at end of month 1931	Stocks at end of month 1932
January	**6,595,000**	4,989,000	**4,692,000**	3,363,000	**27,759,000**	25,568,000
February	5,920,000	....	5,074,000	....	28,612,000	....
March	8,245,000	....	7,192,000	....	29,676,000	....
April	11,245,000	....	11,184,000	....	29,715,000	....
May	14,010,000	....	14,200,000	....	29,554,000	....
June	14,118,000	....	16,077,000	....	27,602,000	....
July	13,899,000	....	15,545,000	....	25,934,000	....
August	13,549,000	....	15,172,000	....	24,313,000	....
September	12,092,000	....	13,671,000	....	22,736,000	....
October	10,762,000	....	12,360,000	....	21,218,000	....
November	8,161,000	....	7,156,000	....	22,219,000	....
December	*5,974,000	....	4,142,000	....	*23,942,000	....
	*124,570,000	....	126,465,000	....	....	....

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*Revised.

Blacker type indicates larger of two figures.

Cement Statistics for December

	1930	1931	Increase or Decrease, %
Production, December	8,480,000	5,998,000	—29.3
Shipments, December	5,688,000	4,142,000	—27.2
Stocks at end of month	25,838,000	24,075,000	—6.8
Total production for yr	160,905,000	124,594,000	—29.1
Total shipments for yr	158,744,000	126,465,000	—25.5
No. of plants reporting	165	165	0

Relation of Production to Capacity

	The Month, Per Cent	The Twelve Months, Per Cent
December, 1931	26.4	46.5
December, 1930	38.2	61.5
November, 1931	37.2	44.4
October, 1931	47.4	48.6
September, 1931	55.3	50.2

Production, Shipments, and Stocks of Finished Portland Cement, by Districts, in December, 1930 and 1931, and Stocks in November, 1931 (In Barrels)

District	Production—December 1930	Production—December 1931	Shipments—December 1930	Shipments—December 1931	Stocks at end of month 1930	Stocks at end of month 1931	Stocks at end of November, 1931*
Eastern Pa., N. J. and Md.	1,939,000	1,434,000	1,469,000	1,310,000	5,036,000	4,774,000	4,649,000
New York and Maine	716,000	458,000	364,000	321,000	1,774,000	1,321,000	1,185,000
Ohio, Western Pa. and W. Va.	769,000	422,000	467,000	282,000	3,587,000	3,450,000	3,310,000
Michigan	614,000	197,000	245,000	153,000	3,096,000	2,054,000	2,011,000
Wis., Ill., Ind. & Ky.	984,000	707,000	394,000	375,000	3,604,000	2,817,000	2,485,000
Va., Tenn., Ala., Ga., Fla. and La.	680,000	596,000	648,000	432,000	1,795,000	1,821,000	1,656,000
Eastern Mo., Ia., Minn. and S. Dak.	906,000	600,000	337,000	212,000	2,403,000	3,098,000	2,710,000
W. Mo., Nebr., Kans., Okla. and Ark.	700,000	688,000	367,000	372,000	2,089,000	1,626,000	1,311,000
Texas	392,000	291,000	362,000	214,000	802,000	726,000	649,000
Colo., Mont., Utah, Wyo. and Idaho	34,000	59,000	46,000	43,000	353,000	501,000	485,000
California	531,000	474,000	755,000	370,000	763,000	1,218,000	1,114,000
Oregon and Washington	215,000	72,000	234,000	58,000	536,000	669,000	654,000
	8,480,000	5,998,000	5,688,000	4,142,000	25,838,000	24,075,000	22,219,000

Production, Shipments, and Stocks of Finished Portland Cement, by Months, in 1930 and 1931 (In Barrels)

Month	—Production— 1930	—Production— 1931	—Shipments— 1930	—Shipments— 1931	Stocks at end of month 1930	Stocks at end of month 1931
January	8,498,000	6,595,000	4,955,000	4,692,000	27,081,000	27,759,000
February	8,162,000	5,920,000	7,012,000	5,074,000	28,249,000	28,612,000
March	11,225,000	8,245,000	8,826,000	7,192,000	30,648,000	29,676,000
April	13,521,000	11,245,000	13,340,000	11,184,000	30,867,000	29,715,000
May	17,249,000	14,010,000	17,224,000	14,200,000	30,891,000	29,554,000
June	17,239,000	14,118,000	18,781,000	16,077,000	29,364,000	27,602,000
July	17,078,000	13,899,000	20,153,000	15,545,000	26,289,000	25,934,000
August	17,821,000	13,549,000	20,299,000	15,172,000	23,824,000	24,313,000
September	16,124,000	12,092,000	18,083,000	13,671,000	21,889,000	22,736,000
October	14,410,000	10,762,000	15,599,000	12,360,000	20,697,000	21,218,000
November	11,098,000	8,161,000	8,784,000	7,156,000	23,056,000	*22,219,000
December	8,480,000	5,998,000	5,688,000	4,142,000	25,838,000	24,075,000
	160,905,000	124,594,000	158,744,000	126,465,000	....	....

Reopening of Petoskey Plant to Take Place Early in April

The Petoskey, Mich., plant of the Petoskey Portland Cement Co. will resume operations about April 1, it was announced at the annual meeting held at that city on January 27.

Cement shipments for 1931 were shown to be only 8 per cent below those of the preceding year.

Directors re-elected for five years are John L. A. Galster and Homer Sly of Petoskey and Herman M. Magnus of Cincinnati. Officers re-elected are: President, J. B. John, Cleveland; vice-presidents, Homer Sly of Petoskey, J. C. Buckbee of Chicago and Herman M. Magnus of Cincinnati; secretary, Emory O. Nyman, and treasurer and general manager, John L. A. Galster.

At the annual meeting of the Petoskey Transportation Co. George W. John of Petoskey and Herman M. Magnus of Cincinnati were re-elected directors for three years. Officers are: President, J. B. John, Cleveland; vice-presidents, Homer Sly of Petoskey, J. C. Buckbee of Chicago, Herman M. Magnus of Cincinnati and H. H. Lucas of Petoskey; secretary, Emory O. Nyman, and treasurer and general manager, John L. A. Galster of Petoskey.

MEN and MILLS

[News of and for Cement Mill Men]

A clearing-house page for all kinds of local cement mill news—to promote the comradeship and mutuality of interest that exists among those who make portland cement.

Readers in all mills, even though not regular contributors, are invited to send in news notes about personal and plant activities that may be of interest or value to the men in other mills.

"Thankful for Work" Is Employes' Spirit on Return to Jobs

"One hundred and fifty men, their faces wreathed in smiles at the prospect of work after months of idleness, resumed their labors Monday morning when the Alpha Portland Cement Company's plant reopened after a long shutdown," begins a report of the event in the *La Salle* (Ill.) *Post* of January 25.

"Long before 7 a. m., the starting hour, scores of the old employes were on hand, anxious to begin their work.

"'It's been so long since I've had a job, or work of any kind, that it's a novelty for me to find that I have steady employment,' one of the mill hands said. He was a young man, with a wife and two small children dependent upon him.

"Another declared:

"'Please don't interrupt; I want to put as much effort into this job as I can. You see I've been off so long that I want to work just as hard as I can to show that I appreciate getting this job.'

"'Everyone is happy,' Superintendent Lundberg said. 'They are all as anxious to show the management that they appreciate the opportunity to get back on the job that it's going to be rather difficult to keep all of them going as fast as they want.'"

New Member Appointed to South Dakota Cement Plant Board

The appointment of C. J. Delbridge of Sioux Falls, S. D., as a member of the state cement commission to succeed Nick Caspers of Rapid City was announced in February by Governor Green. The appointment was to go into effect March 1.

Governor Green also announced that George Philip of Rapid City has been reappointed and made secretary-treasurer of the commission, and that H. P. Gutz of Selby is to be chairman of the commission, succeeding Mr. Philip, who has held the chairmanship for some time.

Hollister Elected Head of Northwestern Portland

New officers elected for the Northwestern Portland Cement Co., Seattle, Wash., on January 8, were C. T. W. Hollister, president; J. A. Reuter and Frank Kiernan, vice-presidents; Carl W. Gath, secretary-treasurer, and H. A. Metcalf, assistant secretary.

Mr. Hollister is the former secretary.

Hoover Dam Subject of Talk by R. M. Willson

The activities taking place in the construction of Hoover dam at Boulder City were the subject of a talk by R. M. Willson, chief chemist of the local Southwestern Portland Cement Co. plant before the members of the Victor Valley (Calif.) Lions Club on January 26.

Mr. Willson, who recently made a tour of inspection at the dam site, used a map in illustrating his talk to show some of the details.

Warden Named Texas P. C. A. District Engineer

The Portland Cement Association has named T. B. (Ben) Warden as district engineer for Texas, with the exception of El Paso County.

Offices will be located in the Dallas Athletic Club building.

Volunteer Transfers Mooney to New Territory

Robert L. Mooney has been transferred to the western North Carolina and eastern Tennessee sales territory of the Volunteer Portland Cement Co.

His territory previously included Georgia and a portion of Tennessee.

C. K. Boettcher President of Colorado Civic Group

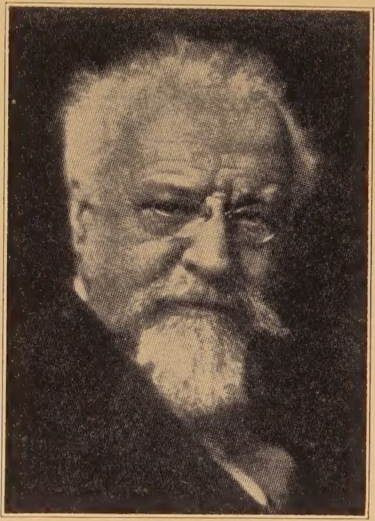
C. K. Boettcher, member of the board of the Ideal Cement Company and a Denver, Colo., banker, was elected president of the Colorado Association.

The purpose of the association is to advertise the scenic beauty and the business qualifications of Denver and Colorado.

Cement Mill Equipment Firm Observes Fiftieth Anniversary

The close of fifty years in the business of supplying cement plants with equipment was observed on January 2 by F. L. Smidth & Co.

The firm was founded by F. L. Smidth in 1882, who was soon joined by two other engineers—Poul Larsen and Alexander Foss. The firm at first undertook consulting engineering work, and specialized in brickmaking plants. In 1888 it designed its first cement works, and shortly took up the manufacture of cement-making machinery, according to *Cement and Cement Manufacture*.



Poul Larsen, chairman of F. L. Smidth & Co.

The firm's first tubemill was put on the market in 1893, and this type of machine is reputed to be in use now in hundreds of cement plants and in the mining industry throughout the world. The first cement works built by the company were erected in Sweden and Denmark.

A branch office was established in London in 1890, in 1893 offices were opened in Paris and St. Petersburg (now Leningrad), and in 1895 a branch was established in New York.

Poul Larsen is the present chairman of the firm and associated companies.

George Warren to Pacific Coast; Jellick Appointed P. C. A. District Engineer

George Warren, assistant general manager of the Portland Cement Association, has established an office at 564 Market Street, San Francisco. Mr. Warren will remain in San Francisco and will have general supervision of the association's Pacific Coast activities, according to the San Francisco *Commercial News*.

J. E. Jellick has been appointed district engineer for the northern and central California territory, with headquarters at the San Francisco office.

Mr. Warren has been identified with the industry for the last seventeen years, of which eleven have been spent in his present position of assistant general manager.

He is a member of the American Society of Civil Engineers and the American Society for Testing Materials. In this latter society Mr. Warren has been very active, having served on a number of committees and as a member of the executive committee.

Mr. Jellick was formerly with the Calaveras Cement Co., prior to which he was Pacific Coast manager for the association.

He is a member of the Engineers Club of San Francisco and has been active in the highways committee of the State Chamber of Commerce.

Advertising Veterans See Cement and Concrete Films

The two motion pictures, "Cement, From Mountain to Cement Sack" and "Concrete Construction That Endures," were shown before the February 22 luncheon meeting of the Advertising Men's Post, American Legion, Chicago, by a representative of the Universal Atlas Cement Co.

New England Plant Given Credit for Continuity of Operation

Local distinction was given the Lawrence Portland Cement Co. plant at Thomaston, Maine, recently when an article in the *Rockland Courier-Gazette* pointed it out as an industry that has continued operation uninterruptedly.

The text, which referred also to community road-building, was accompanied by an 8-column illustration of the plant and a portrait of Plant Manager C. H. Sonntag.

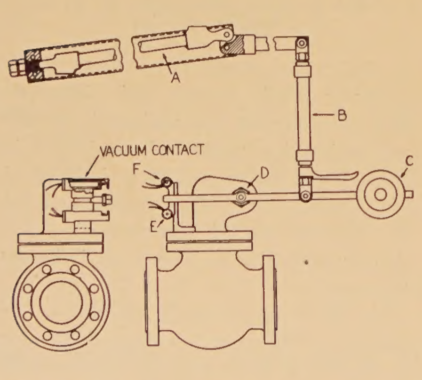
Six Directors Re-elected to Ideal Board

At the recent annual meeting of the stockholders of the Ideal Cement Company, at Denver, Colo., the following directors were re-elected: Charles Boettcher, C. K. Boettcher, James Q. Newton, Harry C. James, Robert S. Gast and R. J. Morse.

Mill Equipment

Valve Signal Device Is New Northern Equipment Product

Northern Equipment Co., Erie, Pa., announces a new electric signal device for use with the control valve on the Copes feed water regulator. It gives instant warning of any abnormal condition in the boiler feed supply by signalling by means of a bell or an electric light if the valve should ever reach the wide-open or fully-closed positions, it is stated.



The application of this new unit is shown by Drawing 17207-S. When expansion tube "A" of the Copes thermostat contracts with rising water level, the motion is transferred through the vertical strut connection and tension relief "B" to raise the weighted lever "C," gradually closing the valve. This lever pivots at the stuffing box "D" and the extended end moves downward. Should some abnormal condition cause the valve to reach a fully-closed position, the lever striking vacuum contact "E" closes the circuit for the "closed" signal.

As water level in the expansion tube lowers, the tube expands, permitting the weighted lever to open the valve gradually. Should the fully-open position be reached, the extended end of the lever strikes vacuum contact "F" and closes the circuit for the "open" signal.

The vacuum contacts are fully protected in a metallic case which is adjustable to any desired position. The signal may be installed on any Copes control valve.

Further information will be furnished on request by the manufacturer.

Industrial Literature

Publication Describes Gearmotors

Gearmotors, consisting of speed reducers compactly combined with induction motors into general purpose unit drives, are the subject of a new publication, *Leaflet* 20536, issued by the *Westinghouse Electric and Manufacturing Co.*, East Pittsburgh, Pa.

Information on application and operation, details of construction, a listing of sizes and speeds, and dimensions are contained in this leaflet.

Copies are available through any Westinghouse sales office or from the company's advertising department at East Pittsburgh.

G-E Leaflets

Loose-leaflets received from the *General Electric Co.*, Schenectady, N. Y., describe the following units: Built-in speed reducers, solenoid-operated valves, pole-changing switches, direct-current motors, Type BTA motors, and totally enclosed, fan-cooled induction motors.

Notes from the Field

Allen-Bradley Exhibit

A complete exhibition of modern electric motor control was held by the *Allen-Bradley Co.*, at the Engineering Building, Chicago, during the entire month of February.

The display was designed to be comprehensive, presenting complete displays in a large area of floor space. The controls shown ranged in size from small push-button stations and photo-electric relays to automatic high-tension motor starters and included standard, water-tight, dust-tight, and explosion-proof apparatus.